Department of the ENVIRONMENT

GOOD PRACTICE CASE STUDY 338

Improving efficiency by renewing boiler burners and controls

Hotel Inter-Continental

- **Annual savings of £13,750**
- **Reduced CO and NO_x emissions**
- **Improved boiler efficiency**
- **Greatly reduced maintenance costs**
- **Reduction in boiler down-time**

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

BEST PRACTICE PROGRAMME

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BACKGROUND

One of the two boilers at the hotel Inter-Continental

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The Hotel Inter-Continental has two 7,700 kg/h gas fired steam boilers which provide space heating and cooling services. The boilers operate continuously throughout the year.

Although the boilers were in good condition the burners were worn, requiring regular servicing, and could not be optimised throughout their full operating range. The air/fuel ratio was set by a cam arrangement, so that performance had to be determined for each reference point. Combustion air was provided by a fixed speed fan and the volume of air to the burner was regulated by a damper driven via linkages from the cam.

The boiler flame suffered from instability and impingement on the tube plates, causing structural damage and costly repairs. Soot generation resulting from inefficient combustion was also a significant problem. Although the hotel had two boilers, the loss of one boiler for major repairs left it potentially vulnerable in the event of a fault.

Due to the hotel's large gas consumption it was decided to install new burners on the boilers, as even a small percentage improvement in fuel consumption would give significant cost savings.

BURNERS AND CONTROLS

The following features allow the new burners to operate at optimum efficiency.

- The gas valves and air damper are actuated directly by servo motors, which position to within 0.1 degree, eliminating the errors created by backlash in the linkage systems. i.e. hysteresis.
- O_2, CO_2 and CO are measured in the exhaust gases and commission values are compared to the on-line value to give a three parameter trim facility. This ensures 'lock-on' combustion performance which inflicts minute control on the air ratio. This is the principal burner control system.
- The existing combustion air fans were fitted with variable speed drives (VSD) to reduce the power consumption drawn by the motor at lower loads, resulting in electricity savings. At 50% of boiler load the motor typically draws only 27% of its normal load. As the boilers never operate at their maximum capacity, savings are always achieved.
- The steam pressure is monitored constantly by an internal Proportional, Integral, Derivative (PID) control and the burners are modulated to maintain continuous boiler firing. This ensures the boiler setpoint is maintained and avoids frequent start/stop cycles.
- A micro-processor based control system integrates the flue gas monitoring system with the burner controls to optimise combustion efficiency and minimise emissions of pollutants.
- The burners have a higher turn-down ratio than the original burners and can therefore operate at lower firing rates. This allows the boiler to operate at a low firing rate for longer periods before it needs to switch off.
- The burners can also be integrated with the hotel's Building Energy Management System (BEMS) for remote monitoring and change of set-points, although this facility is not used.

This project was monitored independently by: NIFES Consulting Group. Tel: 01279 658412

The equipment was manufactured and supplied by: Autoflame Engineering Ltd. Tel: 0181 695 2000

There may be other suppliers of similar energy efficiency equipment in the market. Please consult your supply directories or contact ETSU who may be able to provide you with more details.

BURNER AND CONTROL SELECTION

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The economics of modern burner and control systems are dependent on a number of factors as shown in the chart (Fig 2). This gives potential users an indication of where such a system may prove viable and the factors which favour the selection of new burner equipment. In general, large boilers with high load factors will have the greatest savings potential. Older burners, which are worn or poorly designed, could give lower than optimum thermal efficiencies over the whole of the firing range. There are, therefore, opportunities for savings if these are replaced, as in the case of the Hotel Inter-Continental.

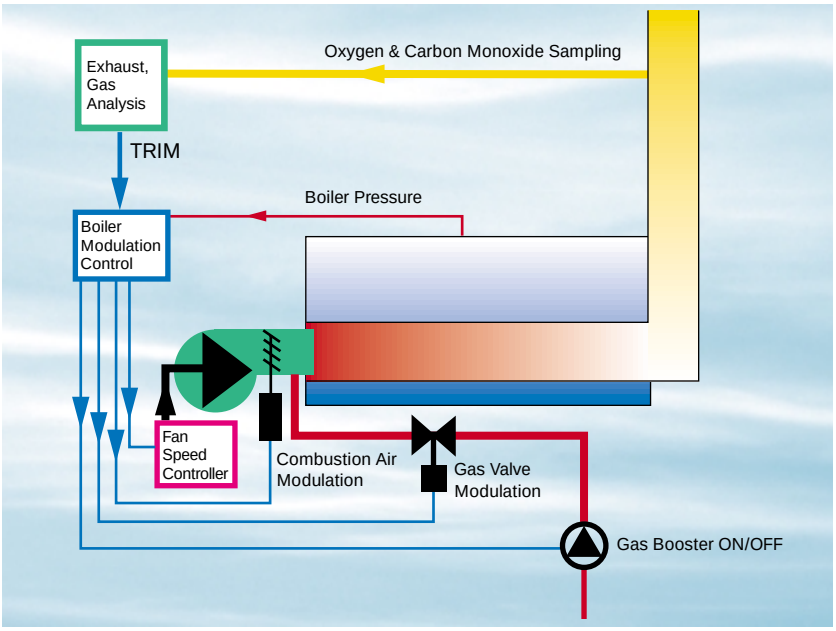

Fig 1 Schematic of burner control

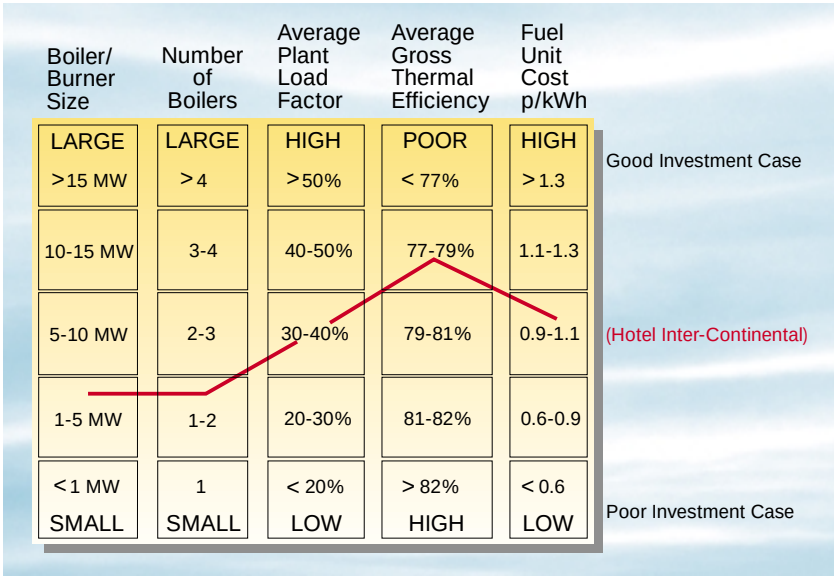

Fig 2 The economics of modern burner and control systems

The position of the Hotel Inter-Continental on the chart gives a simple payback period of 4.5 years. If the overall position is above this value, an even better payback can be expected.

USE

Select the point on each column where you consider your boiler installation. Draw a line between the columns as shown in the example. If the line is straight across the table then the relative investment case can be easily read off on the right. Otherwise an average position should be interpreted.

Fig 2 should be used as an indication of the potential viability of upgrading burners and controls. The plant owner should consult with the burner and controls supplier for a detailed economic appraisal for upgrading.

DEFINITIONS

Boilers/burner size - The thermal output of each boiler/burner in MW, or average size if there are a number of different sized boilers/burners.

Number of boilers/burners - The number of boilers installed or, if greater, the number of burners (e.g. twin burner boilers).

Average plant load factor

$$\text{Load Factor} = \frac{\text{Annual fuel input (MWh)} \times \text{Plant efficiency (\%)}}{\text{Plant output rating (MW)} \times 8{,}760 \text{ (Hrs)}}$$

Boiler efficiency - This should be taken as the Gross Thermal Efficiency at the average firing rate of the boilers, i.e. if two boilers operate at mid fire, the efficiency at this point should be taken, or if one boiler is generally firing at high fire and one at low fire the average of these two efficiencies should be taken.

BURNER AND FAN CONTROLS

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Combustion air supply (and therefore air/fuel mixture) is regulated by a combination of controls from the micro modulation system.

The VSD on the induced draught fan is controlled by set points stored within the controller. This modulates the air delivered by the fan to slightly in excess of that required for combustion at any position of boiler load. The air flow is further regulated by a damper in the burner which is controlled initially in relation to the optimum O_2, CO_2 and CO set-points within the controller. This is then trimmed back by the monitoring system to reduce this pollutant to trace levels, while maintaining optimum thermal performance and 'lock-on' combustion levels.

The close coupling of burner firing rate and optimum air/fuel ratio improves efficiency at low loads. This is particularly important during the spring and autumn when lower heating and cooling requirements decrease the boiler load factor and therefore the seasonal efficiency of the boilers.

BURNER INSTALLATION

The burners were installed in two phases. The first burner, installed in September 1992, was so successful that the second boiler was converted three months later.

The existing front mounted combustion air fan was retained. This has the advantage of:

- drawing air down the front door;
- assisting in structural cooling;
- pre-heating the air to improve combustion efficiency.

A frequency inverter based motor VSD was fitted to each fan.

The new burner at the hotel

COSTS

A total of £49,720 was invested in upgrading the boiler combustion systems, of which the new burners and controls accounted for approximately £39,000; the remainder was for new gas boosters and speed controllers for the induced draught fans. (1993 prices).

HOST ORGANISATION

As a company, Inter-Continental Hotels and Resorts has for many years pursued energy conservation as part of its overall global commitment to wider environmental issues.

In the early 1990's it became evident that the existing burners at the Hotel Inter-Continental, London, were neither energy efficient nor environmentally friendly, due to the NO_x emissions. A decision was therefore made to invest in one new burner to ascertain its benefits to the hotel and the environment. After just one month the results were so impressive that a second burner was purchased. The hotel's energy operating costs are now much lower, with NO_x emissions well below statutory levels. In addition, the improved combustion of the boilers has resulted in much reduced costs during the annual boiler maintenance programme.

Peter Lancaster, Chief Engineer, The Hotel Inter-Continental

THE HOTEL INTER-CONTINENTAL

The nine storey Hotel Inter-Continental, built in the early 1970's, is one of an international chain of luxury hotels. Situated on London's Hyde Park Corner, the hotel features 467 bedrooms and suites, restaurants, ballroom, conference and leisure facilities.

Over the last 12 years, the engineering department has implemented a series of measures to reduce energy consumption and costs.

In 1992 the hotel received the City of Westminster's Energy Conservation Award in recognition of its achievements.

RESULTS AND CONCLUSIONS

SAVINGS SUMMARY

Item	Annual energy saving (GJ)	Annual cost saving (£)
Gas	1,450	3,710
Electricity	460	5,040
Maintenance	–	5,000
Total	1,910	13,750

CONCLUSIONS

Gas savings of 1,450 GJ/year worth £3,710 were achieved from the improved thermal efficiency of the boilers. This equates to 3% of the annual gas consumption of the boiler plant.

- Electricity savings of 256 GJ/year were achieved from a reduction in the power consumption of the smaller gas compressors operating directly with the burner. A further 200 GJ was saved by reducing the power consumption of the induced draught fan when firing at lower loads. These savings are worth £5,040/year to the hotel.
- Since the burners were converted, the hotel has experienced no structural damage to the boilers and the need to clean the gas paths has been virtually eliminated. The reduction in maintenance costs is worth approximately £5,000/year.
- Improved thermal efficiency has reduced emissions of carbon dioxide by 175 tonne/year and carbon monoxide emissions by 6.0 tonne/year. The new burners are also designed to produce lower NO_x emissions.

ADDITIONAL BENEFITS

The flame envelope of the new burners is shorter than in the original burners, thus eliminating impingement on the rear tube plate. This has significantly reduced the down-time of the boilers and associated maintenance costs.

The reduced stress on the boiler structure and refractory brickwork has also minimised down-time and maintenance costs.

Typically, the incidence of burner failure is highest during the start-up sequence when all controls are tested and the boiler is purged. The closer control of the burner firing rate with steam demand, coupled with the greater turn-down ratio, reduces the frequency of burner starts and therefore the potential for failure.